HORTICULTURE VALUE CHAIN
Mushroom Technical Activity Report

February, 2011

This publication was produced for review by the United States Agency for International Development. It was prepared Mickey Foley, Mushroom Specialist, for USAID-*Inma* Agribusiness program for a consortium led by the The Louis Berger Group, Inc.

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Executive Summary

Due to security problems and transportation issues, the consultant was not able to carry out the project at Hameedyah Mushroom Farm as it was planned. Difficulties arose because travel to the project site was only possible for four days during the six week project. However, communication with the host by email and through exchanging photographs did supplement the visits and some production problems were identified, changes were recommended and adopted. Suggestions were made, such as modifying the Hameedyah compost recipe, modifying the compost turning schedule, and modifying the procedure for adding casing soil. These changes were made and will probably increase production significantly. The biological efficiency of Hameedyah mushroom farm is currently fairly good. They are operating profitably with an average production of about 17.5 kilograms of mushrooms per square meter, while their goal is 20 kilograms per square meter.

With time to study the problem from a distance, it finally became clear that the main reason Hameedyah Mushroom Farm did not meet the expectations of their business plan, 19 MT of mushrooms per month compared to 7 MT tons per month actual production, is because the business plan was based on incorrect assumptions. Due to some misunderstanding, the business plan is based on planting 950 square meters per week, but the farm actually only has the capacity to plant 475 square meters per week. The production goal should be 9.5 tons per month, so the biological efficiency of the farm is not as bad as first thought, 7.0 MT compared to 9.5 MT, or about 75% of the expected level.

The consultant used the time to learn about other mushroom production facilities in Iraq and was able to arrange consultations with some of the other facilities. See the revised scope of work below for a list of these projects. Details of these additional projects are included in this report. The most significant project added to the SOW is Al-Fter Agriculture Investment Company, building a $2.2 million Agaricus (champignon) production facility near Erbil. They requested financial assistance from USAID-*Inma* to help with start up costs. The consultant met with the owner manager, visited the construction site, attests to the soundness of the design and feasibility of the project and hopes USAID-*Inma* Agribusiness Program will be able to assist this company.

Revised Scope of Work

The scope of work was changed due to unforeseeable circumstances; the consultant was able to visit the primary project only four times during the 54 day consultancy. Therefore, he had time to learn about other mushroom projects in Iraq, establish contact with people involved in those projects, and to offer them technical assistance. Four training seminars, part of the original scope of work, were conducted at USAID-*Inma* offices in Baghdad and Erbil for project staff and for interested people from the community.

Hameedyah Mushroom Farm Revised SOW

The primary project was to provide technical assistance to Hameedyah Mushroom Farm, recipient of USAID-*Inma* Agribusiness Program grant of $623,287 in 2008 to restart production. Hameedyah Mushroom Farm began production in June 2009, and since then the farm has been producing about half of the volume of mushrooms anticipated in the business plan. A mushroom consultant was requested to identify the constraints to production and propose solutions to increase production. The consultant expected to spend three to four weeks at the farm and observe the daily operations to become familiar with the work procedures in order to make good recommendations. However, only four days on site were possible.

Yet some significant observations were recorded, discussed, and remedies were proposed and adopted during the project.

Al-fter Agriculture Investment Company Added to SOW

The scope of work was expanded to include evaluation of a $2.2 million Agaricus mushroom farm under construction near Erbil City in the Kurdish region of Iraq. The owner and chief engineer of the Valley Mushroom Project requested that the USAID-*Inma* mushroom specialist evaluate their project, business plan, and if possible, to offer technical and financial assistance. A-Fter began construction in July 2010 and expects to begin producing mushrooms in June 2011.

Kurdistan Ministry of Agriculture Added to SOW

Kurdistan Ministry of Agriculture officials requested consultations to discuss their desire to start a mushroom growing cooperative in Northern Iraq.

Abdul Rahmann Ali Oyster Mushroom Farm Added to SOW

This farm began production of oyster mushrooms (Pleurotus species) in 2010, but stopped after six months due to production problems caused by mushroom diseases. They requested technical assistance to help them with re-starting production.

Najat al-Mikael Oyster Mushroom Farm Added to SOW

Owner attended training seminar at the USAID-*Inma* office in Erbil and requested a technical consultancy to improve production at their small farm.

Nameq Rashid Added to SOW

This individual sent an email to USAID-*Inma* in January 2011 and told about his plans to establish an agaricus mushroom farm near Kirkuk. He requested a meeting to discuss his plans.

Hameedyah Mushroom Company Background

Hameedyah Mushroom Farm (HMF) was established in 1984. It is located approximately 18 kilometers west of the city of Ramadi, Iraq. The company is privately owned by the Khirbit family. The farm was constructed using Dutch equipment, designed for a Dutch production method that was developed in the 1980s. Farm operations were hampered by Desert Storm in 1993 and were halted in 2004 after bombing destroyed a house on the property and killed one of the Khirbit brothers. In 2008 they received a USAID-*Inma* Agribusiness Program grant of $623,287 to repair the farm and begin operating again.

The farm has eight production rooms, each with 500 square meters of production space. Each room has sixteen growing beds, thirty square meters per bed, four layers high and four rows wide. Beds are filled and emptied by winching nylon nets in and out of the beds.

This farm uses a traditional phase I composting method (no aerated floor or bunkers), pre-wet in pyramid piles, and followed by composting in long narrow piles turned periodically by machine. Phase II pasteurizing and conditioning is carried out in a tunnel, followed by phase III incubation after spawning in an identical tunnel. There are two sets of tunnels, because the original design included 16 growing rooms. Only eight of the growing rooms have been finished to date, but tunnel construction to fill 16 rooms has already been completed. Having an extra set of tunnels means there is no rush to complete phase II, pasteurization of compost, in five days time because a second phase II tunnel is available for filling the next batch of compost. This is an advantage and a convenience because the problem of clearing ammonia from the compost in five days is not a problem here. In addition several days are available for cleaning and maintenance of the tunnel between each crop.

Production Related Information in HMF Business Plan

Production projections in the HMF business plan are for 19 MT of mushrooms per week. Calculating a yield of 20 kg per square meter per crop cycle, weekly planting of 950 square meters per week would be required to achieve this goal. This is double the actual current production area of the farm.

The original 1980s plan for the farm did include sixteen production rooms; however, eight of the rooms were never completed. The foundations were poured, and a roof was built overhead, but no doors, air handling units or production shelves were ever installed. HMF has eight operating production rooms, 500 square meters each, and one room per week is planted.

It seems that the business plan estimate was based on sixteen production rooms, and on filling two 475 square meter growing rooms per week. A realistic production projection will be 475 square meters per week at 20 kg of mushrooms per square meter, yielding about 9.5 MT per week. Therefore, the farm is operating at about 73% of the goal, 7 MT actual weekly average production compared to a goal of 9.5 MT per week.

HMF- Review of Raw Materials

During visit to the site on January 23, 2011, raw materials and composting equipment of HMF were evaluated. Composting materials, spawn, and casing soil were all good quality. Composting materials are wheat straw, dried poultry waste (DPW), and gypsum powder. Spawn is imported from reputable suppliers in the Netherlands and Italy. Casing soil is imported from the Netherlands and is very expensive to transport, because it is shipped in 20 liter bags with 60-70% moisture.

Wheat straw

Wheat straw is sourced from the owner's cousin's farm in Iraq. HMF uses 17 MT of wheat straw per week, starting a new batch of compost every Thursday.

Observation and Discussion - The straw was good quality, clean and bright, wheat straw, judged to be good for making mushroom compost.

Recommendation - It was observed that the nylon strings were not removed from the bales of straw. These strings foul the machinery during the whole process, cause delays and breakdowns, and should be removed before pre-wet begins. Counting the strings would improve the accuracy of the bale count, too. The cost of labor to remove and count the strings would be a good investment.

Dried Poultry Waste (DPW)

DPW is sourced from Mosul, Ninawa Province. HMF currently uses 9 MT DPW per batch of compost. A double car load of DPW costs $3-4,000 with transport included. HMF requires two loads per month costing approximately $8,000 per month.

Observation and Discussion

- DPW is mixed with wood chips and is cleaned from the chicken houses according to an unknown plan.
- An unknown number of broiler production cycles occur before house is emptied and manure is shipped to HMF.
- Quality of broiler feed is not known.
- Number of chickens per square meter is not known.
- The number of kilograms of sawdust per number of broilers is not known.
- Nitrogen level of DPW is estimated from one laboratory analysis done in 2010.
- The moisture level of DPW might be as high as 40-50% (60-50% is dry weight) but HMF is currently calculating at 12% moisture (88% dry weight). This could lead to underestimating level of nitrogen added to compost by as much as one ton of DPW.

Previously HMF bought manure from a State owned chicken farm 5-6 km from the mushroom farm, but that farm no longer exists and is now a housing development. There are new broiler farms near Fallujah, but HMF cannot compete to buy that manure as it is sold to sheep farmers for a feed additive at a higher price than HMF farm is willing to pay.

Recommendations - HMF should learn more about DPW supplier. Establish a contact at DPW supplier and ask to be notified when changes in feed, bedding, or production schedule occur. DPW supplier should learn that consistency is very important to HMF. Ask DPW contact person to telephone HMF and report the following information about each $4,000 load of DPW:

1. What kind of sawdust is used for the floor?
2. How much (volume or weight) of sawdust is used per chicken housed?
3. How many cycles of production before broiler house was cleaned out?
4. How much time passed before the unloaded DPW is delivered to HMF?
5. What is the composition of the chicken feed, especially want is the % protein of the feed?

2. Consultant believes the level of moisture is more than 12%. See the darker color inside the lump. Level of moisture in DPW should be verified using the following steps:

- Weigh a sample
- Oven dry the sample at 80° C for 24 hours
- Weighing the sample again
- Divide the dry weight by the wet weight
- Multiply the result by 100
- Subtract the result from 100 - to arrive at the % dry matter

Formula: $100 - (\frac{\text{dry weight}}{\text{wet weight}} \times 100)$ = % of dry matter

3. Establish a baseline nitrogen level. Find a laboratory in Iraq that performs animal feed analyses and send one sample a month for six months for analysis.

Gypsum

HMF currently uses 1,450 kg of gypsum per batch of compost. The amount used is consistent with industry norms.

Observation and Discussion - HMF is using gypsum manufactured to be used to plaster walls, bought in bags. The gypsum is very good quality, white powder gypsum, but is expensive at 8,000 ID for a 30 kg bag. HMF would prefer to buy bulk gypsum for agriculture use, but does not know of a source in Iraq.

Recommendations - USAID-*Inma* field staff could assist HMF by checking about Iraqi sources for agricultural gypsum, calcium sulfate, a commonly used soil amendment to soften clay soils, is usually mined and comes out in chunks and should be powdered for use in mushroom compost.

Soybean Meal

HMF buys soybean meal in bags, using 500 kg per batch of compost, adding at mixing turn 2 or mixing turn 3.

Observation and Discussion – Soybean meal is a very good nitrogen supplement and will help to increase temperature in the compost. HMF is adding soybean meal to the compost mix, but the amount of nitrogen added is not calculated in the compost recipe.

Recommendations – Add soybean meal to the written HMF compost recipe and include the soybean meal nitrogen in the calculation: 500 kg soybean meal at 10% moisture = 450 kg dry weight X .05 (5% nitrogen or about 30% protein) = 22.5 kg nitrogen.

Urea

HMF adds 100 kg of urea to the compost.

Observation and Discussion - HMF uses only ½ the amount of urea that is used on their Egypt mushroom farm, because the owner/manager believes that the Iraq straw is “weak” (thinner) and will break down too much if more urea is used.

Recommendations – Review of the original MNF compost formula (See **Table 1** below) suggests that the level of nitrogen in the recipe could be increased. Starting nitrogen is calculated to be 1.45% N in the raw materials. It could be increased to 1.6-1.7% N. HMF should recalculate the level of nitrogen in the compost based on actual moisture in DPW and include nitrogen from the soybean meal in the calculation. If calculated level of nitrogen is less than 1.6%, (See **Table 2** below**)** add more urea, DPW, or soybean meal to the recipe (see **Table 3** below**)** for recommended recipe with additional 1,000 kg DPW and additional 100 kg urea.

Original HMF Compost Recipe

Table 1 – Owner/Manager sent to the consultant by email on January 16, 2011

Material	Wet Weight	% Moisture	Dry Weight kg	% Nitrogen	Kg Nitrogen
Straw	17000	10.00%	15300	0.5	76.5
DPW	8000	12.00%	6500	3	195
Urea	100	0.00%	100	46	46
Total			**21960**		**317.5**
Gypsum	1450		1450		

Kilograms nitrogen 317.5 / 21,600 kg dry weight = 1.45% nitrogen

Compost Recipe as Presented on 1/13/2011

Table 2 - This recipe uses higher moisture level for DPW and accounts for nitrogen from soybean meal. Actual level is calculated to be slightly lower because of higher moisture in the DPW. Changes to original recipe are highlighted.

Material	Wet Weight	% Moisture	Dry Weight kg	% Nitrogen	Kg Nitrogen
Straw	17000	10.00%	15300	0.5	76.5
DPW	9000	40.00%	5400	3	162
Urea	100	0.00%	100	46	46
Soybean meal	500	10.00%	450	5	22.5
Total			**21250**		**307**
Gypsum	1450		1450		

Kilograms nitrogen 307 / 21,250 kg dry weight = 1.44% nitrogen

Compost Recipe to Increase Level of Nitrogen 1/23/11

Table 3 - Changes to original recipe are highlighted.

Material	Wet Weight	% Moisture	Dry Weight kg	% Nitrogen	Kg Nitrogen
Straw	17000	10.00%	15300	0.5	76.5
DPW	10000	40.00%	6000	3	180
Urea	200	0.00%	200	46	92
Soybean meal	500	10.00%	450	5	22.5
Total			**21950**		**371**
Gypsum	1450		1450		

Kilograms nitrogen 371 / 21,950 kg dry weight = 1.69% nitrogen

Measuring Weight of Compost Raw Materials

Measuring the weight of raw materials used in the compost recipe is important. It is also important to determine the level of moisture in the weighed materials, because the compost recipe is based on the dry weight of the ingredients.

Observation and Discussion - A problem for management to solve is how to accurately measure bulk compost ingredients. The problem is that Hameedyah Mushroom Farm Management does not know exactly how much straw and chicken manure is being laid out for each batch of compost. When the farm was built, a truck scale was installed to weigh the truckloads of straw for one batch of compost. The scale disappeared. Now, the amount of straw is estimated, but not very carefully. Although the weight of one bale of straw is known, the bales are not really counted. A scoop machine picks up a “load” of bales and a guess is made as to how many bales are included.

It was observed that the nylon strings were not removed from the bales of straw. These strings foul the machinery during the whole process, cause delays and breakdowns, and should be removed before pre-wet begins. Counting the strings would be another method to improve the accuracy of the bale count. The cost of labor to remove and count the strings would be a good investment.

Measuring dried poultry waste (DPW) with a scoop-loader is probably accurate enough, provided that workers are trained to periodically measure the weight of small (20 liter) buckets and are taught to realize that it is important to know how many small buckets fill a scoop-loader level full. Employees need to be reminded each week to level (with a shovel, or stick) each scoop of DPW before it is dumped onto the pile of straw.

Lumps of chicken manure could still be found in compost after phase II. Currently workers try to break up the lumps by back-blading the material with a loader bucket. This method might not always be successful. A hammer-mill or some other machine is needed to break up the lumps of chicken manure more successfully.

Recommendations – The above procedure should be written down as part of a standard operating procedure (SOP) and the date of last verification recorded. For example: January 31, 2011, 20 liter bucket weighed “X” kg. One scoop-loader bucket is filled by “XX” buckets.

Adding Water to Compost Stacks

The level of moisture in stacks of compost is very important. If compost is too dry or too wet, the desired temperature (>70^0 Celsius) will not be achieved.

Observation and Discussion - HMF adds water to the top of compost stacks. The consultant believes this causes the temperature of the stacks to cool to levels below optimum for producing good compost, – 65^0 C at the top of the stack and 45^0 C at the bottom of the stack. Stack temperature samples measured as low as 57^0 at the top. (Too cool) Temperature should be >70^0C at the top of the stack and >60^0 C - 40 cm up from the bottom of the stack. HMF does not usually measure the temperature of the compost stacks. Typically, no water is added to top of compost pile after it is stacked. All the water is added as a machine turns (mixes) the compost. HMF turning machine does not have water nozzles.

Recommendation – A water spray bar should be installed on the turning machine. The consultant discussed this with the owner manager and he intends to install a water bar with spray nozzles very soon.

Compost Mixing Schedule

Total number of days and the number of times compost ingredients are mixed during the preparation process varies in commercial operations depending on the machinery used and the raw materials mixed.

Observations and Discussions – At HMF Phase I compost schedule is 20 days, 1-7 days in large pre-wet stack, days 8-18 in ricks (long narrow piles), and final 2 days in large pyramid pile. Pre-wet schedule for mixing DPW and straw seems satisfactory, but the number of machine mixings (3) while the compost is in the ricks seems too few. HMF makes 3 turns on the compost ricks – leaving the rick for 3 or 4 days between turns. The consultant stated that in the USA ricks are often turned every 2 days and suggested that HMF add at least one more turn to the composting schedule. The consultant emphasized that four days between mechanical mixings is too long. The compost temperatures will likely fall and the risk of anaerobic fermentation increases with four days between turns.

Recommendations – Add one more mechanical mixing turn to the compost cycle: add 1-ton DPW on day 5; add 100 kg urea on day 2 (See recommended modifications to the schedule highlighted in the table below)

Table 4 - Mushroom Compost Making Activity Schedule

Day of week	Cycle	Current Activity	Proposed Activity
Thursday	1	17-ton straw, 4-ton DPW, 100 kg urea. Break bales, mix, water	17-ton straw, 4-ton DPW, 100 kg urea. Break bales, mix, water
Friday	2	add water with hose to pre-wet pile	sprinkle 100 kg urea on top of pile, add water with hose to pre-wet pile,
Saturday	3	3-ton DPW, mix with scoop machine add water	3-ton DPW, mix with scoop machine add water
Sunday	4	add water	add water
Monday	5	1-ton DPW, mix with scoop machine	2-ton DPW, mix with scoop machine
Tuesday	6	add water with hose to pre-wet pile	add water with hose to pre-wet pile
Wednesday	7	add water with hose to pre-wet pile	add water with hose to pre-wet pile
Thursday	8	Form stack with turning machine, add 1,450 kg gypsum to top of stack add one hour dark water on top of stack	Form stack with turning machine, adding water at front of machine add 1,450 kg gypsum to top of stack
Friday	9	sit	sit
Saturday	10	sit	spread 1-ton DPW on top of stack
Sunday	11	spread 1-ton DPW on top of stack	Turn with machine; add water at front of machine as machine works
Monday	12	turn with machine, add water to top of stack before turning	sit
Tuesday	13	clean water on top of stack as needed	sit
Wednesday	14	sit	Turn with machine; add water at front of machine as machine works.
Thursday	15	clean water on top of stack as needed	sit
Friday	16	clean water on top of stack as needed	sit
Saturday	17	turn with machine, add water to top of stack before turning	Turn with machine; add water at front of machine as machine works.
Sunday	18	clean water on top of stack as needed	sit
Monday	19	clean water on top of stack as needed	sit
Tuesday	20	move to Phase II tunnel	move to Phase II tunnel

Compost Record Keeping

Temperature of compost stacks should be monitored and recorded. Compost temperatures are not regularly measured. They should be. A written record should be kept of the temperatures and saved together with the records from phase II, phase III, and from the growing room, as well. The record should be reviewed at the completion of each crop and then a formal evaluation should be made to correlate the level of production with empirical data recorded.

Lack of Compost

During the visit, it was observed that four beds in room number six were empty. It was pointed out to the owner that four empty beds out of 16 beds amounts to 25% of the total planting area left empty. Subsequently it was observed that every room had empty beds. Four to six beds in each room had been left empty simply because there was not enough compost after phase III to fill the space. Some beds were perhaps empty, because compost had been thrown away after phase III because high temperature killed the mycelium due to low air flow. But in most cases, simply not enough compost had been prepared.

It is a difficult job to prepare the correct amount of compost to fill 500 square meters in each room with 90-100 kilograms of compost per square meter. Due to many factors, the percent of shrink during the composting cycle varies from batch to batch and it is nearly impossible to end up with exactly the same amount of compost week after week. But it is reasonable to expect that about 40% shrink in dry weight will occur during the 20-days of phase I, 7-days of phase II and 14 days of phase III.

Therefore, to fill growing rooms to full capacity, 500 square meters filled with 100 kg of compost per square meter, 50 tons of compost will be required. Based on observations and calculations, it is estimated that 35-40 tons of compost are currently available after phase III. Current compost bulk ingredients are 17 tons of straw and 9 tons of chicken manure. After subtracting moisture, it is calculated that about 21 tons of dry matter enters the process at phase I, subtract 40% shrink during the process, this leaves 12.6 tons produced at the end of phase III.

To have 50 tons of compost at (70% moisture) available for filling the growing rooms, 15 tons of dry matter is needed after phase III. To reach this goal, start with 20 tons of straw (10% moisture) and 12 tons of chicken manure (30% moisture), for a total of 26.4 dry tons. Calculate shrink at 40%, this leaves 15.8 tons dry mater at the end of phase III. This is equal to about 50 tons of compost at 70% moisture (50 tons x 30% dry matter = 15 tons).

Filling Phase II Pasteurizing Tunnel

Compost in the phase II tunnel is filled only about 1.5 meters deep. From the picture, it is easy to see that more compost could be filled. Now there are 5 end boards, but end brackets were designed for two more end boards. If tunnel was filled to the level of 7 boards high, about 30% more compost could be filled into the tunnel compared to current practice.

After Phase II, compost looks very nice. No condensation on surface or along edges, white flecks of heat molds are uniform throughout the compost.

The bottom slide and glide nets are brand new and could handle 30% more compost than is prepared now.

Phase III Compost

Fourteen days after planting spawn, Phase III tunnels are emptied and compost is transported to the growing rooms.

Observations - Inspection of compost showed that insulation in the tunnel is excellent. There was little condensation either along the walls or on the top surface of compost.

Top surface had been inoculated heavily with spawn.

During the unloading process we could see that some areas in the compost were not colonized with mycelium.

Recommendations – Reduce the amount of spawn broadcast on the top surface of compost. Spawn would be better utilized mixed throughout the compost.

The black areas shown in the picture below are probably due to high concentrations of ammonia in lumps of dried poultry waste in the compost. Consider how to pulverize dried poultry waste with a hammer mill or other grinder to remove the lumps.

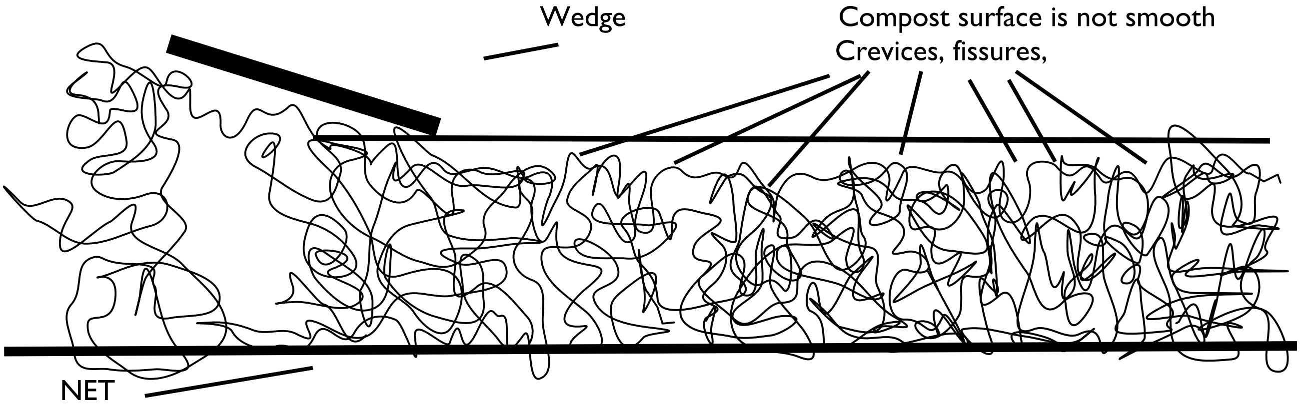
Casing Soil

(Moist peat moss mixed with calcium carbonate) – HMF has a regular source for casing soil. It is imported from the Netherlands in small bags. One bag covers one square meter.

Observation and Discussion - The material imported from the Netherlands is nice quality, but very expensive delivered to Iraq. 20 kg bags of peat moss are premixed with moisture and pH adjusted. To make casing soil on site would involve a learning curve and experimenting with various types of soil and is not recommended. There seems to be no economical substitute for the Dutch import available in Iraq.

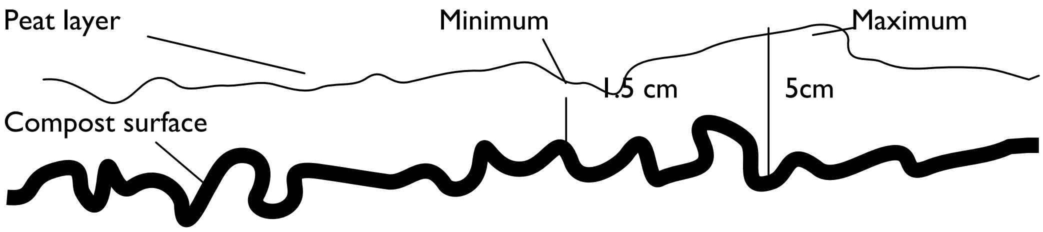
Casing soil should cover the compost with a layer about 5 cm thick, but because peat is so expensive, HMF attempts to spread peat only about 3 cm thick. At HMF a Dutch Thilot machine spreads the casing soil on the compost as it is being winched into the bed. When using Thilot machinery to apply casing soil, it is difficult to apply a layer that completely covers the surface of the compost even when the machinery is set to meter out a 5 cm layer. With the HNF goal of a 3 cm depth of casing soil, some areas of the growing beds have casing soil too thin to support good mushroom yields.

The Thilot machine tries to compress compost by forcing it through a wedge. This does not compress as well as a roller, or a flat board that tamps the surface. The "wedge" does not leave a smooth surface, and it can also make fissures in the surface. Peat then falls into these crevices.



EVENESS OF PEAT ADDITION

HMF Evaluates uniformity of peat moss layer in the production room by making 60 measurements of the depth of the peat



Recommendations - Stop using the Thilot casing machine and instead spread peat on the surface of the compost manually, after tamping the compost surface flat with wooden boards. This recommendation was made on January 23, 2011, and during the second site visit on January 31, 2011, it was observed that HMF had adopted this recommendation, see pictures below.

Spawn

HMF imports widely used strains of spawn from reputable companies in the Netherlands and Italy,

Observation and Discussion - HMF uses several popular hybrid strains, X25, X28, F599 from Italy. They are experimenting with small amounts of brown varieties to grow portabella. The strains they are using are popular with growers and from reputable suppliers. The owner believes X28 is superior to X25.

Spawn looks healthy and clean. No evidence of contamination or senescence.

Recommendations – None

Logistics Problem

Bringing supplies (peat and spawn) across the Iraqi border is expensive.

Observations and Discussion - Peat moss and spawn crossing the Iraq - Jordan border requires HMF to pay bribes 4,000 € to cross the border and additional 4,000 € at checkpoints until it reaches the farm.

Recommendations – This consultant is not qualified to recommend ways to solve this corruption issue.

Request - Can USAID-*Inma* help fight corruption and bribes at the border?

Measuring Level of Carbon Dioxide in Growing Rooms

The amount of fresh air needed to dilute CO_2 produced by growing mushrooms varies according to the number of mushrooms present on the surface and on the temperature of the compost in the beds. These factors change day by day.

Observation and Discussions – HMF's CO_2 meter is not calibrated, so he is not using it.

Recommendations – The consultant suggested that the owner/manager calibrate the meter based on CO_2 in natural air. HMF's CO_2 measuring device is a standard model and the operator's manual is available online with instructions about how to calibrate the unit. The manual should be downloaded and the meter calibrated and used in each growing room.

Environmental Control System

Automated climate control is considered essential for good production of fresh mushrooms. Computers continuously make changes to positions of dampers, to motor speed, to heating valves, to cooling valves, to humidity valves.

Observation and Discussion –A very nice climate control system has been installed, but the company from which it was purchased (AEM in the Netherlands) did not send an expert to set up the system and assure that it was operation properly. HMF owner/manager hired an Iraqi expert to set it up, but it was not completed. Thus this expensive, sophisticated programmed computer control system with real time monitoring and recording of temperature, relative humidity and CO_2 level for each production room is not operating.

Recommendation – An IT specialist is needed to connect the computer in the control room to the controllers outside the production rooms. All cables have been installed, but some I/O device (ADC converter) is needed to connect all the cables to the computer. This is important work! Who can do this?

Mushroom Training Seminars

USAID-*Inma* requested consultant to conduct training seminars for people interested in beginning mushroom production. Oyster mushroom production was chosen as the topic for these seminars because oyster mushrooms are easy to produce, compared to white button (Agaricus) mushrooms. Oyster mushroom can be produced using simple technology and a wide range of agriculture waste materials are suitable for use as substrate.

Lack of mushroom spawn is a problem in Iraq, so one seminar covered the basic steps of how to produce mushroom spawn using a stove top pressure cooker and a homemade culture transfer chamber.

January 6, 2011- Thursday
Presented training in USAID-*Inma* conference room on techniques for producing oyster mushroom on small farms with simple technology.
Persons attending training:
Fadhil Awad Mishaan
Anmar Ibrahim
Ahmed Hasin
Omar Al Wahed
Ahmed Yaseen
Ali Saadoon
Hassan Mohamed
Emad Ateya
Yaha Kahdom
Atheer Al Nassir

Wednesday January 12, 2011
Training Seminar in USAID-*Inma* office
Mohammed Khalid, translator
Attendees:
Shaker Wady
Adel Alewi Hussain
Talib Khalil Kadhum
Raad Kafel Jassem
Haider Habeb
Majid Abdul Al-Hameed
Mohammed Mahmood Aisa
Thamer Alewi Hussain
Asem Mohan Jassem
Hadi Abdul Al-Zahra
Haider Ahmed Hazma
Haider Radhi Hussain
Haider Radhi Hussain (same name as previous- different person)
Aws Al-Awsi

List of USAID-*Inma* Staff Participants in Oyster Mushroom Training at Erbil Office on January 25, 2011.

#	Name of Participant	Position	E.mail	Tel
1	Ashqi Ahmed Hussein	GFA Horticulture Senior Officer	asahmed@inma-iraq.com	7504632423
2	Aso Kurdo	GFA Field Officer	akurdo@inma-iraq.com	7504468877
3	Rami H. Nassory	Feed Mill Officer	rnassory@inma-iraq.com	7504368828
4	Rostom Sarkis Haroutune	Senior Project Officer/Engineer	rharoutune@inma-iraq.com	7701605533
5	Waqas Asaad Ali	GFA Field Senior Officer	wazari@inma-iraq.com	7706101644
6	Layth Jerjees Jallo	GFA Field Senior Officer	ljallo@inma-iraq.com	7702470778

List of Participants in Mushroom Seminar at USAID-*Inma* Erbil Office on January 26, 2011.

#	Name of Participants	Location	Tel
1	Sardar Sami Nuraddin	General Director of Extension, Training & Research	07504513584
2	Lukman Ali	Directorate of Forest & Horticulture	07504493004
3	Najat Hamad Qadir	MOA Agricultural Engineer	0750 4495990
4	Abdulsatar Faraj	Agricultural Engineer in G.D. of Erbil	07504510743
5	Meran Zakarea	Agricultural Engineer in MOA	07504545624
6	Fahme Abduahad	Agricultural Engineer	07504702271
7	Nawzad Ali Aziz	expert in MOA	07504475209
8	Mahmud Hamza Shekho	expert in MOA	07507553793
9	Kamaran Mamand Anwer	Farmer -Anikawa	07504533711
10	Hazhar Rasul Yassen	Farmer - Qushtapa	07504603230
11	Bahaaddin Ahmed Muhammed Amin	Farmer - Dashty Hawler	07504085558
12	Muhammed Mustafa Muhammed	Farmer - Slahaddin	07504548468
13	Abdulmaseh Marqus	Extension Center – Ainkawa	07504484771
14	Eman rauf Marf	Agricultural Engineer in MOA	07504499320
15	Khasro Mamand Anwer	Director of Extension & Training	07504827968
16	Arfan Fateh Shukir	Agricultural Engineer Research Center Erbil	07504284058
17	Saman Sabir Ali	Agricultural Engineer Research Center Erbil	07504882147
18	Annemik V. Waranden	Cara fruit Horticultursl	07505418661
19	Hewa Ali Kurshed	Naja Mushroom Project	07504455819
20	Najat Nawe	Naja Mushroom Project	07504728793

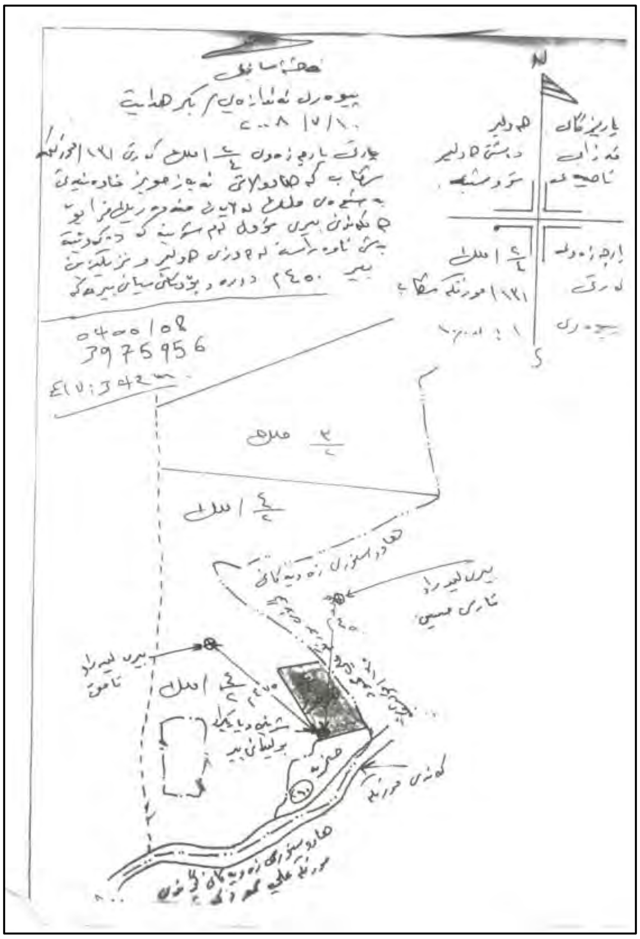
Al-Fter Company – Valley Mushroom Project

MUSHROOM PROJECT IN ERBIL PROVINCE –KURDISTAN AREA
BOARD OF INVESTMENTS Licensed Project 276 (License No 302) date 07/17/2010
Wade Al-Fter Company for Agricultural Investment USD $2,229,000.

Information about this mushroom production facility was developed by Consultant, Mickey Foley, Mushroom Specialist for USAID-*Inma* Horticulture Team in Baghdad and Ashqi Hussein, USAID-*Inma* Horticulture Senior Officer in Erbil.

Background

On January 26, 2011, Dr. Saham Hazm Aloose owner of Wade Al-Fter Company for Agriculture Investment and his engineer for Valley Mushroom Farm, being constructed near Erbil, Alaaddin Abdulrazaq, met with Mickey Foley and Ashqi Hussein to share details about then Valley Mushroom Project and to request that USAID-*Inma* provide technical and financial assistance for starting up the farm.



Since July 2010, Wade Al-Fter spent over $2 million USD on site preparation and construction of a mushroom farm near Erbil, Kurdistan.

Dr. Saham Alus was born in Iraq-Mosul in 1960, and graduated from Mosul University in 1982 where he studied irrigation and drainage engineering. He earned a PhD in water-development works, land improvement and irrigated farming from the USSR-Moscow in 1992. He moved to Jordan in 1994 and started a mushroom farm not far from Amman. In 2007, he designed and built another mushroom farm in Cairo, Egypt. Then, in 2009 he built another mushroom farm with the same design in Beirut, Lebanon. Dr. Alus has designed the new farm in Erbil based on his experience growing mushrooms in the Middle East and his knowledge of the climate and market in this region.

Wade Al-Fter expects to begin preparing compost on April 1, 2011 and to harvest the first mushrooms in mid-June. Full production of 30-40 tons of fresh mushrooms per month is expected during September 2011.

On January 31, 2011, Dr. Alus attended the "Future of Marketing Forum" sponsored by USAID-*Inma* and met with the forum keynote speaker, Mr. Bruno Brassart, store manager, of Carrefour Hypermarket in Erbil to discuss packaging and delivery schedule for fresh mushrooms to be sold in Carrefour's fresh produce department. Dr. Alus also met with Craig Carlson, USAID-*Inma* Business Development Specialist, and gave him a copy of Wade Al-Fter's business plan.

Site Visit

On February 8, 2011, Mickey Foley, Mushroom Specialist for USAID-*Inma* Horticulture Team in Baghdad and Ashqi Hussein, USAID-*Inma* Horticulture Senior Officer in Erbil visited the Al-Fter construction site.

Business Plan

Crain Carlson has a copy of AlFter's business plan. It was written in Arabic and is being translated.

Request for Financial Assistance

1) Spawn for 1 year production - that is about 24000-30000 L (about $45,000);

2) Casing soil for 1 year production, that is 600 m^3 (about $48,000);

3) Plastic trays for packing mushrooms 2,000,000 punnet (plastic tray) x 250 g which is enough for 1 year production (about $120,000);

4) Fuel to run the generators for electricity of the farm for 6 months which is about ID 200,000 (ID 700/liter about $118,143);

5) Salaries for the whole team of workers, manger, accountant...etc. for 6 months (about $200,000);

6) Refrigerator small trucks for marketing the production, 5 trucks for different cities of Iraq (about $ 50,000);

7) New filling line or used one in a good condition to fill our phase II tunnels (about $50,000);

8) One standby generator of 500 KVA as 2 are always working (about $70,000);

9) Middle size front loader new or used in good condition to turn compost in composting yard & move compost later to phase II tunnels (about $100,000);

10) A cold store container for the spawn (about $25,000);

11) Good internet connection (about $5,000);

12) Computer controls for our phase II tunnels (about $30,000)

13) New small compost turning machine or used one in a good condition (about $60,000)

14) Tractor with a trolley to handle dry straw (about $30,000)

15) Two caravans for the management of the farm (about $10,000)

Kurdistan Ministry of Agriculture

Experimental farm

MOA Experimental Gardens of the College of Agriculture of Salah ad Din University

People who attended the meeting:

Sardar Sami, General Director of Extension Training and Research
Khasro Mamand, Director of Training
Sardar Khatab, Director of Research
Eman Rauf Marut, Technologist
Bland Muhammed, Technologist

During a previous visit to Erbil (25

January), Ashqi Hussein scheduled a meeting with Sardar Sami at the International Hotel and he asked the consultant to consider how the MoA could start an extension program to produce mushroom compost and mushroom spawn for farmers in the region. He said they have underground greenhouses that could be converted to grow mushrooms, a compost making area, and a laboratory where they could learn to make mushroom spawn. It was agreed that if the consultant visited again, he would look at the places and make suggestions about whether the locations could be practically modified for such a project.

The Experimental Garden is a pretty, peaceful place, about 150 meters wide and 400 meters long, with many interesting plants growing. Soft, green, low growing ground cover surrounds the walkways. Mossy stairs lead to three underground greenhouses, each 7 meters wide, 18 meters long, with 2.5 meter walls below ground level and a glass gable roof about 3 meters high at the peak. Semi-tropical plants are rooted in the ground and hundreds of small pots with starts and cuttings fill spaces among the rooted plants. Even a purple Dutch iris was blooming, pretty nice to see in February. The complex has an area for hoop houses and annual vegetables, approximately 100 meters wide and 300 meters long. There is a bee keeping project in one corner of the complex. Many senior and junior technologists were milling about grounds, cleaning beds and making cuttings. The Experimental Garden was like a peaceful park.

The underground greenhouses are 40 + years old, concrete walls have cracks, metal supports for glass panels sag. These buildings are in their twilight years. They are impractical for mushrooms having no drains and a dirt floor.

Laboratories

The consultant visited the MOA laboratory complex to determine if any of the labs are suitable for beginning mushroom spawn production. The soil analysis lab and the plant pathology labs were visited to see the equipment available. They have one table top incubator suitable growing Petri plates.

They have a top loading autoclave with a chamber about 30 cm x 100 cm that could be used for sterilizing agar media and grain. The capacity is about 12 one liter bottles or 3 five liter bottles.

They do not have a laminar flow work station where sterile culture transfers could be made. They think the MOA may have a laminar flow work station in Sulaymaniyah.

Compost Preparation Area

The compost making area, located in the forestry nursery complex was visited. There compost for nursery stock is made, but not on a regular schedule. The area is nothing more than a concrete slab about 50 x 50 meters with a drainage system to route the runoff into an adjacent field. There was no evidence of electricity installed there and no equipment is dedicated to the site.

Summary

Probably none of the three locations are suitable for beginning mushroom production, even on a pilot scale. The General Director is very interested to begin a large-scale white button (agaricus) mushroom production program and thinks the Ministry of Agriculture would make funds available for this purpose. However, for a cooperative association to come into being, probably a few established growers are a prerequisite, growers whose needs “bubble up” so that they decide to pool resources to afford to buy some specialized machinery, or to produce spawn for their own needs, or they might decide to band together for marketing. This consultant feels that it is unlikely that a successful agaricus mushroom growing cooperative organization can be started from government “trickle-down” policies when no small or medium size agaricus mushroom farms even exist now, and there are currently no trained mushroom extension agents or support personnel at Ministry of Agriculture.

However, there are already some oyster mushroom growers in the region, and they really need a source of spawn and technical support. Compared to white button (agaricus) mushrooms, oyster (pleurotus) mushrooms are easy to produce. Unlike white button mushrooms, expensive compost making equipment is not needed to prepare substrate for oyster mushrooms. There is not an objectionable odor from the process. Substrate for oyster mushrooms can be prepared from wheat straw alone, simply chopping, watering and pasteurizing the straw is all that is required. Participating farmers need a growing room with good environmental control, heating and cooling, but do not need expensive compost making machinery.

If the Kurdistan MOA becomes interested in promoting oyster mushrooms, instead of white button mushrooms, it could become a good project. Bags of inoculated substrate could be distributed within a 200 km radius and farmers could market their own mushrooms. During the past decade, oyster mushroom business has exploded in the Ukraine and Russia and small scale out-growers demonstrate the success of this business model.

Marketing oyster mushrooms in Iraq will take time to educate the consumer. For this reason, small growers, near markets, will be the pioneers to make oyster mushrooms popular in Iraq. In Turkmenistan, Kazakhstan, Uzbekistan, and Kyrgyzstan small oyster mushroom producers have started production during the past 15 years and are now well established. Fresh oyster mushrooms can be found in many open air markets in large and medium size towns.

Abdulrahman Ali Geathadin Oyster Mushroom Farm

This mushroom farm is near the Erbil wholesale produce market. It has 3 halls, each hall is 450 m^2. Inside each hall 4 rooms are partitioned with plastic walls, the area for each room is 120 m^2. The farm has been in production, but has now stopped production to clean the rooms because of disease problems.
Tel: - 009647504685419 0 **Location N. 38 SMF 02408 E. MGRS 04212**

Substrate Preparation

Observations and Discussion - Left side of the picture (below) shows the soaking tank. Wheat straw is submerged in cool water with a fungicide solution for 3-4 hours. Then the wet straw is moved to the back-left tank fitted with a propane burner underneath and boiled for 3-4 hours. Then wet, boiled straw is placed on a screen (right-side) to drain away excess water.

Recommendations – Soak straw in cool water with calcium hydroxide $Ca(OH)_2$ or calcium oxide CaO for 30 minutes only. Calcium oxide and calcium hydroxide are available in many different products and concentration of the active ingredient is not always known. To judge the amount of product to add to the water, a pH meter is necessary. Add calcium oxide or calcium hydroxide to water until pH is 14. Then add straw until the pH drops to 9. Soak straw for less than one hour.

Boiling and Cooling Substrate

Straw is boiled for 2-4 hours in a tank (on right), then boiled straw is placed on a screen (on left) to drain. With this method, the straw at the bottom of the tank is very hot; straw on the top and sides of the tank is cooler. The room is open. The air is not filtered. The straw can easily become contaminated by airborne spores as it cools. After the straw has cooled enough to handle, it is placed in a wheelbarrow and moved to a separate room for inoculation. The wheelbarrow is not covered during transport.

Recommendations – Heat straw to 70 C degrees maximum. Install a hot water pump to circulate hot water from the bottom of the tank to the top of the tank. Without a pump, water on the bottom of tank will be much higher than 70 C degrees because of heat from propane flame. Heating for one to two hours at 70 C degrees is enough time.

When the straw cools in open air, it is easily re-contaminated with airborne spores. Construct a plastic tent over the straw and install a strong ultra-violet lamp to kill spores inside the tent. Cover the wheelbarrow with plastic while moving straw to the inoculation room.

Inoculating Substrate (Spawning)

Observations and Discussion – Straw is placed on a table prior to mixing spawn. The room seems to be clean and the spawn is stored in a special box. Although the surfaces seem to be clean, it seems to the consultant that the vector of airborne contamination is not well understood. Shoes are changed at the entrance to the inoculation and growing area, but the door is open to the outside air. Even when closed, the door does not fit well and cracks can be seen, so air can easily enter the "clean" chamber.

Recommendations – Fungicide previously used in the soaking tank can be sprinkled on the straw and mixed in before adding the spawn.

Incubating Substrate

Bags filled with straw and spawn are hung inside growing rooms for three weeks while spawn colonizes the substrate.

Observations and Discussion – The bags observed had no ventilation holes cut in them, excess water was standing in the bottom of the bags as well. The diameter of the bags is wider than optimum, substrate in the center of the bags will heat up during incubation. The electric heater with bucket of water on top is effective for heat and humidity. Notice the plastic bags on feet, they asked consultant to wear them or change to "inside" shoes. So, they think about hygiene, they do clean floors and walls, but they do not seem to understand the risk of airborne spores.

Recommendations – Make cuts in the plastic bags to allow water to drip out of the bottom. And poke some holes in the bottom and sides for ventilation. Currently they wait until the entire room is filled before making holes in the bags. It takes two days to fill one room, so anaerobic bacteria will begin growing and spoil the bag. Bags should be 25-35 centimeters diameter, but bags can be longer than currently used; as long as 1 meter, to hold the same weight of substrate. Narrower bags will not heat up so much in the center during incubation.

Production Rooms

The layout of the rooms causes a severe problem with cross contamination from old production rooms to new rooms where bags are in incubation.

The four rooms are all connected to a common corridor. Air from the corridor is blown into the rooms and exhaust air goes out of the rooms back into the corridor.

Recommendations – The ventilation system must be modified so that air from the old rooms does not get sucked into the new rooms. During incubation, the first three weeks after planting, ventilation inside the rooms should be under positive pressure. Air must be supplied from outside the building, or, if from inside, it should be filtered down to <5 microns. After incubation, the pressure should be reversed. During production of mushrooms, rooms should operate with negative pressure, with air being sucked out of the room and exhausted outside of the building.

Najat ali-Mikael Oyster Mushroom Farm

Background

Najat Mikael and his son operate a small oyster mushroom farm near Erbil. They learned from Inma Horticulture Officer, Ashqi Hussein, about our mushroom training seminar at the Inma Office in Erbil on January 26, 2011. They both attended the seminar and asked many interesting questions. At the seminar they gained new information about growing mushrooms. Najat is passionate about growing mushrooms and had obviously thought long and deeply about how they grow and was eager to learn more.

He has learned to produce oyster mushrooms from Iranians. A young Iranian man lives at the farm and is the contact person to bring spawn from Iran. He taught them the methods used in Iran to grow oyster mushrooms and they are learning. They began producing mushrooms in 2010 and have two production rooms. One room is 3 meters by 14 meters; the second room is 14 x 11.5 meters. They do not have a ventilation system, but have electric heaters with buckets of water on top to make heat and humidity.

They sell their mushrooms for $7-9 per kilogram at a market in Ankawa, a village near Erbil. They can sell only 20-30 kg per week at this market, but they think more markets in their region would buy mushrooms if they could provide a regular supply.

They want to establish spawn production, to open a substrate preparation company and sell inoculated bags to out-growers. Hopefully in a future project, they can liaison with the Kurdistan MOA and work to establish an oyster mushroom grower cooperative in the Erbil area.

Site Visit

The consultant visited and observed their production site on Wednesday, February 9, 2011.

The consultant brought mushrooms back to Mansur Compound Dining Facility in Baghdad for sampling.

Nameq Rashid Agaricus Mushroom Proposal

Email requests

Dr. Nameq Rashid sent an e-mail to USAID-*Inma* requesting assistance with a mushroom production project in the Kirkuk Province. Dr. Rashid has a PhD from a university in the United Kingdom and a Masters Degree from a University in Utah. Last year he studied growing mushrooms at the Solan Agriculture Experiment Station in Himachel Pradish, India.

The consultant communicated with Mr. Rashid by e-mail and met with him in Erbil at the International Hotel on February 9 to discuss his project.

Meeting in Erbil

Dr. Rashid requested a USAID-*Inma* grant of $500,000 to realize his project. After asking for more details, it became clear that he has not thought his project through very carefully. He did not yet have a piece of land. He did not know what size of buildings he would need. He did not know how many mushrooms he would produce per week, month, or year. He did not know where he would sell the mushrooms.

The consultant suggested that he make more detailed plans, including a site map and building plans, a marketing plan, and a business plan. Only then should he contact Inma again to ask for technical assistance to evaluate his project.

Travel Schedule:

December 26, 2010 – PDX-ATL-CDG-AMM

December 27, 2010 – AMM-BGD

January 23, 2011 – 7:00 a.m. departed Mansur Compound with Sallyport PSD for Hameedyah mushroom farm near Ramadi. 9:00 a.m. arrived at HMF – 9:30 a.m. until 1:30 p.m. Walked through farm with manager Nawaf Khirbit and discussed production problems. – 1:45 p.m. departed with PSD for trip back to Baghdad and arrived back at Mansur compound at about 3:30 p.m.

January 24, 2010 – 12:00 p.m. departed Mansur Compound with Sallyport PSD to Baghdad International Airport. 5:00 p.m. departed for Erbil. Arrived at International Hotel at 7:30 p.m.

January 25, 2011 – 9:30 a.m. departed International Hotel with Sallyport PSD for Inma Office in English Village in Erbil. 3:30 p.m. Departed Inma office with Sallyport PSD and returned to International Hotel.

January 26, 2011 - 9:30 a.m. departed International Hotel with Sallyport PSD for Inma Office in English Village in Erbil. 3:30 p.m. Departed Inma office with Sallyport PSD and returned to International Hotel.

January 27, 2011 – 7:00 a.m. departed International Hotel with Sallyport PSD for Erbil Airport. 9:00a.m. departed Erbil and arrived in Baghdad at 10:30 a.m., departed Baghdad Airport with Sallyport PSD and arrived at Mansur Compound at noon.

January 31, 2011: 7:30 departed Mansur Compound with Unity Resources Group PSD, for HMF near Ramadi. Arrived 9:30 a.m. Consulted with farm manager Nawaf Khirbit . Departed HMF at 1:30 p.m. Arrived Mansur Compound at 3:30 p.m.

February 1, 2011 - 7:30 departed Mansur Compound with with Unity Resources Group PSD, for HMF near Ramadi. Arrived 9:30 a.m. Consulted with farm manager Nawaf Khirbit. Departed HMF at 1:30 p.m. Arrived Mansur Compound at 3:30 p.m.

February 2, 2011 - 7:30 departed Mansur Compound with Unity Resources Group PSD, for HMF near Ramadi. Arrived 9:30 a.m. Consulted with farm manager Nawaf Khirbit . Departed HMF at 1:30 p.m. Due to checkpoint closures we arrived Mansur Compound at 5:30 p.m.

February 7, 2011 – 12:00 Departed Mansur Compound with Sallyport PSD to Baghdad Airport, departed Baghdad Airport at 5:00 p.m. Arrived at Erbil Airport at 6:30 p.m. traveled with VSC Security PSD to International Airport.

February 8, 2011 – 9:00 a.m. and Ashqi Amed (Inma Horticulture Officer for Erbil) for MOA experimental farm, Al-Fter's Valley Mushroom Project, MOA laboratories, MOA composting site. We returned to hotel at 2:30 p.m.

February 9, 2011 – 9:00 a.m. departed International Hotel with VSC Security and Ashqi Amed (Inma Horticulture Officer for Erbil) for Abdul Rahmann Ali Oyster Mushroom Farm and to Najat ali Mikael Oyster Mushroom Farm. We returned to hotel at 2:00 p.m.

February 10, 2011 – 7:00 a.m. departed International Hotel with VSC Security for Erbil Airport. 9:30 a.m. flew to Bghdad, was met by Sallyport PSD and transported back to Mansur Compound at 12:10 p.m.

February 17, 2011 – Left Mansur Compound, expect to fly BDG-AMM-CDG-ATL PDX and be home in Oregon on Friday, February 18th at about 10:30 p.m.